

# METAL CASTING

## Project Fact Sheet



## MACRO-INCLUSIONS ATLAS

### BENEFITS

- Publically-available, easily accessible Internet tool
- Analysis and photos available on a wide range of samples applicable to foundry operators
- Atlas of oxide macro-inclusions found in foundry-produced steel grades

### APPLICATIONS

Troublesome macro-inclusions may be identified from the atlas and the actual foundry practice parameters may be compared. When the composition of the inclusion has been determined, the origin of the inclusion and the factors causing its occurrence are deduced. This tool assists foundrymen to take corrective measures to prevent the reappearance of the inclusion. The analysis includes determining the size and composition of oxide macro-inclusions found in foundry-produced steel grades, investigating the stable and metastable phases which form during steel processing, and determining the mechanisms of inclusion formation and elimination.

## INTERNET SITE ASSISTS FOUNDRIES ANALYZE MACRO-INCLUSIONS WHICH OCCUR DURING FOUNDRY PROCESSING

The Macro-Inclusions Atlas provides foundry operators with access to information which they can apply on a real-time basis to reduce the frequency of macro-inclusions. Through the analysis of the chemistry and size of problematic inclusions, foundry operators can determine potential sources of macro-inclusions and identify countermeasures to reduce their occurrence. The Atlas is available on the Internet at <http://neon.mems.cmu.edu/afs/atlas.html>.

The problem of macro-inclusions in steel castings has plagued all stages of steel castings and is particularly problematic in foundry processing and in the continuous casting of sheet steels and wires.

Macro-inclusions are a major factor in the rejection of castings, contribute to the reduced in-service life of cast components and result in component remanufacturing. Reducing macro-inclusions, through the use of tools such as the Macro-Inclusions Atlas, can significantly increase foundry productivity and result in significant energy savings by reducing remanufacturing requirements.

### MACRO-INCLUSIONS ATLAS: SAMPLE ANALYSIS

Samples are being analyzed by microprobe, SEM and optical microscope. The Inclusions Atlas characterizes and provides the results of each sample analyzed including information on:

- Chemical analysis (weight percent) of the cast metal
- Defect characterization including information on point of detection, location of defect, and melting practice data
- Final deoxidation practices
- Ladle treatment of the steel and ladle data
- Lining type
- Pouring practice on defective casting
- Molding process on defective casting
- Molding binder
- Coring process on defective casting
- Coring binder
- Gating practice



The illustration shows a sample that has been analyzed by the CMU researchers. This 7 lb. sample, 97.507% iron by weight, was melted in an induction furnace.

**The Atlas provides defect descriptions, mapping and chemical composition for foundry samples.**



## Project Description

**Goal:** To classify and determine the origin of the macro-inclusions formed during casting. To develop an atlas of the oxide macro-inclusions found in foundry produced steel grades and make the resource available on the World Wide Web.

Macro-inclusions are related to three major problems: 1) deoxidation/reoxidation, 2) slag entrapment and 3) erosion of refractory materials during steel pouring. All three problems occur during foundry processing.

Researchers at Carnegie Mellon University analyzed inclusions samples provided by over 13 foundries and the University of Alabama. The results of the analysis, identifying the causes of macro-inclusions and corrective measures to reduce their occurrence, are now available on the World Wide Web.

## Progress and Milestones

- Collected samples from over 13 foundries and the University of Alabama. All company-level information is held confidential.
- Evaluated the effect of melt and ladle refractories and molding refractories on the macro-inclusion content of steel.
- Thermodynamic calculations were made to determine the stability of specific inclusions and were compared to inclusions data.
- Through computer analysis, researchers calculated the equilibrium concentrations of solutes in the metal-inclusion and slag metal-inclusion systems.
- Developed a macro-inclusions atlas that correlates inclusion identification with potential operating problems and solutions.
- Instituted a World Wide Web site to make the Atlas publically available.



### PROJECT PARTNERS

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